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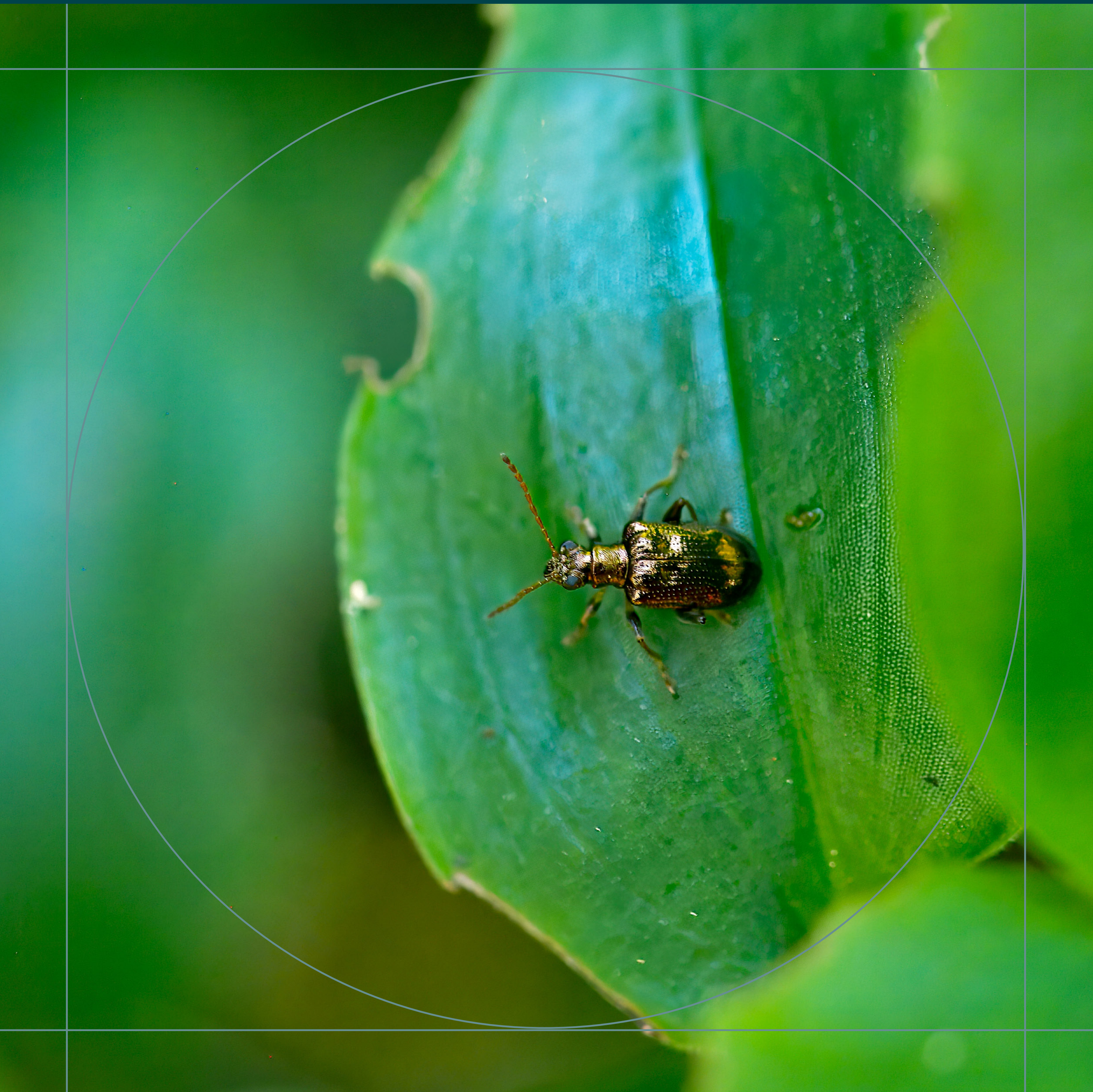
# Weed Biocontrol

WHAT'S NEW?



## Contents



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COVER IMAGE:
Tradescantia leaf beetle.

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# More damage, less biomass: monitoring progress of tradescantia biocontrol

Four classical biocontrol agents targeting tradescantia (*Tradescantia fluminensis*) have been present in New Zealand's environment for up to 14 years. Three chrysomelid beetles – the tradescantia leaf beetle (*Neolema ogloblini*), stem beetle (*Lema basicostata*), and tip beetle (*N. abbreviata*) – were first released between 2011 and 2013, and the smut fungus (*Kordyana brasiliensis*) was first released in 2018. All four agents are now well established, and the leaf beetle and smut fungus, in particular, have spread from their original release sites, where their impacts are becoming increasingly apparent. Consequently, it's a good time to take stock of how effective they have been at reducing tradescantia's harmful impacts.

The effort to estimate the impacts of the tradescantia agents began before their release in New Zealand. Between 2006 and 2010, during the initial stages of the tradescantia biocontrol programme, native range surveys were conducted in southern Brazil to identify candidate biocontrol agents. Coinciding with these surveys, Simon Fowler and colleagues from Manaaki Whenua – Landcare Research, now a group of the Bioeconomy Science Institute, collected data in both Brazil and New Zealand to compare tradescantia biomass between the two countries. The contrasting survey results indicated why tradescantia is such a successful invader in New Zealand: the average tradescantia dry biomass here was almost three times greater than that recorded in Brazil (455 $g/m^2$ compared to 164 $g/m^2$, respectively).

These results made sense: there was more tradescantia biomass but less damage in New Zealand than in Brazil, and we hypothesised that this was because New Zealand lacked the specialised enemies keeping tradescantia in check. This research confirmed that the researchers were looking in the right part of the world for candidate tradescantia biocontrol agents. It also provided baseline data that could subsequently be compared with biomass data collected in New Zealand after biocontrol agents were released.

Such data have now been collected in a recent post-release monitoring study in collaboration with regional councils and landowners. Ten permanent quadrats were set up per site at 24 release sites so that tradescantia biomass could be estimated non-destructively before and after the establishment of biocontrol agents. Quadrats were set up when the agents were released, at which time initial biomass data were collected, and the sites were revisited between 2018 and 2025 to remeasure biomass. We used biomass as a measure for comparison because it is associated with the cover and average height of the tradescantia mat above soil level. Previous ecological studies indicated that the target for biocontrol success was to reduce tradescantia biomass to below 200 $g/m^2$ (dry weight), which is the threshold allowing native plants to regenerate through the mat of tradescantia foliage.

The agents did not establish at five sites, making them impromptu controls for comparison with our findings from the other sites. Although the initial intention was to compare the impacts of individual agents, this was hard to assess because agent self-dispersal was too good. Most sites where where only one species was released had been colonised by one of the other agents. Chris McGrannachan, a researcher at the Bioeconomy Science Institute (BSI) who has been leading the monitoring work, noted that, "by the time we revisited the 11 monitoring sites where agents established, four had leaf beetles only, one had stem beetles only, four had leaf beetles and the smut fungus, one had both leaf beetles and stem beetles, and one had three agents present – stem beetles, leaf beetles, and the smut fungus. Unfortunately, we couldn't assess the impact of the tip beetle because the quadrats at the only survey site where it established were washed away in a flood," he added. Consequently, for the analysis, presence or absence of biocontrol agents, regardless of species, was compared.

Chris found that tradescantia biomass significantly declined at sites where agents successfully established. Prior to agent release the average dry weight biomass at sites was close to 500 g/m$^2$. After agent establishment the average biomass was slightly above 100 g/m$^2$, which is well below the 200 g/m$^2$ threshold needed for native regeneration. In contrast, at the five sites where agents had not established there was no significant reduction in biomass.

The post-agent release biomass data were also compared to the data collected from Brazil and from New Zealand prior to agent release. Biomass in New Zealand after agent release was considerably lower than before agent release and had decreased to levels similar to those recorded from Brazil. These results together demonstrate that the biocontrol agents are effectively reducing tradescantia biomass at sites where they have established.

"Although the analysis combined biocontrol agents, it is clear to us that three agents appear to be capable of reducing tradescantia biomass to below threshold levels," said Quentin Paynter, a senior researcher with the BSI who has been involved in the tradescantia work since early survey work in Brazil. "Biomass has declined below threshold at all sites with the leaf beetle only, and we have also observed both the stem beetle and the smut fungus clear tradescantia patches on their own," he added, noting that the beetles seem to prefer warmer, drier sites, and the fungus copes best in cooler, damper sites, so the agent impacts appear to complement one another.

Putting these results together reveals a heartening outcome for tradescantia biocontrol in New Zealand. The agents are capable of reducing tradescantia biomass at sites where they have established to levels observed in the native range, and to the point where native vegetation is able to regenerate. At some sites the results have been spectacular. A kahikatea forest remnant site in north Waikato has seen a near complete disappearance of tradescantia after the leaf beetle, stem beetle, and smut fungus all established there between 2019 and 2021. This site is now seeing recovery of native ferns and tree seedlings, an impossible outcome had the tradescantia remained dominant (see photo below). Our hope is to continue monitoring changes in tradescantia biomass in New Zealand over the long term and to expand data collection to more sites throughout the country.

*This work was funded by the Ministry of Business, Innovation and Employment's Strategic Science Investment Fund in the Bioeconomy Science Institute's Beating Weeds programme.*

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Tradescantia in north Waikato before agent release.

Same site in north Waikato after agent release.

# Biocontrol of giant reed encounters hurdles

The team in the BSI have been exploring options for biocontrol of giant reed (*Arundo donax*) in both the Pacific and New Zealand, but success remains elusive. Giant reed is a tall, woody, Eurasian grass that now occurs in tropical, subtropical, and warm temperate regions on all continents except Antarctica. It has been introduced to many countries and territories in the Pacific region, including the Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Hawaii, Nauru, New Caledonia, Palau, Samoa, Tonga, and Wallis and Futuna.

Giant reed is sterile and propagates by stem or rhizome fragments, which establish readily. In riverine areas plant fragments can be dispersed rapidly during floods. Elsewhere, human activities such as plantings for stabilising earth on embankments and ornamental garden planting are a major source of infestations.

Giant reed can cause severe ecological disruption by displacing other vegetation and forming dense monocultures, reducing floral and faunal diversity. It can also alter ecosystem services by increasing fire risk, and, in drier regions, by depleting valuable water reserves. Riverine infestations can also restrict the size of river channels, causing floods and damage to infrastructure.

"Giant reed first attracted our attention as an invasive weed in the Pacific region in 2012," said Quentin Paynter, a BSI researcher who took part in a scoping study to prioritise weed biocontrol targets in the Cook Islands. "It ranked highly because of its perceived importance by stakeholders in Rarotonga, and because damaging biocontrol agents had already been developed for it, making it a relatively inexpensive target with a seemingly excellent chance of success."

Two biocontrol agents, sourced from France and Spain, have been established in the USA and Mexico to control giant reed since 2009: a gall wasp, *Tetramesa romana* Walker, and an armoured scale insect, *Rhizaspidiotus donacis* Leonardi. A third agent, a leaf-mining fly, *Lasioptera donacis* Coutin, failed to establish. "The gall wasp and scale insect have been correlated with a significant decline in giant reed and the recovery of native flora at release sites in Texas," Quentin noted.

A shipment of the gall wasp and scale insect was obtained with the assistance of Dr John Goolsby, a US Department of Agriculture research entomologist based in Texas, and rearing commenced in anticipation of approval to release them in Rarotonga. However, things didn't turn out as planned. "During a visit to Rarotonga to survey potential release sites we hit a snag – we couldn't find any giant reed!" said Quentin. It turned out that what had been assumed to be giant reed infestations were actually another tall invasive grass called elephant grass (*Cenchrus purpureus*). "We eventually located a small giant reed patch, but it was restricted to one property and the consensus was the infestation was eradicable, so it wasn't worth the effort of releasing biocontrol agents," Quentin added.

In New Zealand, giant reed occurs in scattered populations on both main islands. Impacts are currently localised but have the potential to become much worse. "It seemed a shame to dispose of the agent cultures that we had imported from Texas," said Quentin. "Luckily, the National Biocontrol Collective agreed to support an application to release the agents in New Zealand, with Northland Regional Council as the applicant."

Host specificity testing already conducted in the USA was extensive and no further testing was required for the gall wasp, and only a handful of native grasses required testing to demonstrate that the scale insect was also adequately host-specific to be released in New Zealand. Environmental Protection Authority approvals were obtained, and the gall wasp was first released in 2017 and the scale insect in 2021.

Giant reed in Rarotonga.

"Signs have not been promising since then," said Quentin. "A year after releases were made, we found a stem with a couple of gall wasp exit holes at one site and we recovered the scale insect from one plant at another site, but last year we couldn't find signs of either agent at two Auckland release sites."

The heavy clay soil at both sites may be unsuitable for the scale insect, which mainly infests the rhizomes. "The soil becomes waterlogged after heavy rain and can be rock hard in summer, although I would still expect to see scale insects on the root collars," said Quentin. "If we can find giant reed infestations on lighter soils – ideally sandy soils – to release the scale on it might be informative," he added.

Several scientific studies conducted since the agents were released offer alternative explanations of why agents have failed to thrive in New Zealand. One study found that gall wasp damage in North America was strongly correlated with growing degree days, with warmer climates favouring higher gall wasp damage than cooler areas. Quentin noted that "based on this study, we hypothesise that the climate in Auckland may be too cool for the gall wasps to thrive and inflict significant damage on giant reed infestations," adding that "the wasp only attacks developing shoots, so stems maturing during cool periods when wasps are inactive will escape attack. Consequently, even if it does establish, we might expect attack rates in New Zealand to be very low."

Although the gall wasp might be expected to perform better in warmer tropical Pacific countries, there's another factor to consider. Invasive giant reed populations do not produce viable seeds and had been assumed to belong to a single sterile clone. Recent molecular studies, however, have identified several genotypes. The invasive genotype in the USA and Mexico originates from the Mediterranean region, where the biocontrol agents were sourced from. In laboratory tests, genetically matched gall wasps from the same region produced more offspring on the Mediterranean genotype compared with other wasp genotypes, indicating that genetic matching may be crucial to success. The Mediterranean genotype of giant reed is known to occur in New Caledonia, but the genotypes in New Zealand and Fiji have recently been matched to plants native to the Himalayas and China.

"Although we successfully reared generations of gall wasps on New Zealand plants, the plant biotype here may be a suboptimal host and, given the wasp is parthenogenetic (meaning it can reproduce asexually), it may struggle to adapt to it. That, combined with the suboptimal climate in New Zealand, might have been too big a hurdle for the gall wasp to overcome," said Quentin.

Scale insect on giant reed stem.

"It would be costly to survey for agents in the Himalayas and China, where we know New Zealand and Fijian plants originated, and the origin of most giant reed populations in the Pacific region is unknown, so we don't yet know the extent to which potential mismatches between agent and weed genotypes might influence biocontrol success," said Quentin. Consequently, we think releases of biocontrol agents sourced from Texas could proceed to combat giant reed in the Pacific region, in tandem with a genetic analysis to determine the origin of giant reed populations, provided stakeholders are willing to accept the risk that the agents that worked well in Texas might not work so well in the Pacific.

*The work on the feasibility of giant reed biocontrol for the Pacific was funded by the New Zealand Ministry of Foreign Affairs and Trade, and the work on giant reed in New Zealand was funded by the National Biocontrol Collective.*

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# More countries in the Pacific identify their top weeds for biocontrol

Two countries in the Pacific, Papua New Guinea (PNG) and the Solomon Islands, recently held workshops to determine their top priority weeds for biocontrol. Both countries are home to some of the world's richest biodiversity, but their unique flora and fauna and ecosystems are being threatened by invasive weeds. These weeds are also invading food gardens, croplands and pastures, making it more difficult to grow food. Waterways are also invaded, which affects activities such as recreation and transport, through to health and traditional practices.

Biological control of weeds in PNG has an excellent track record, with PNG previously a regional leader in the use of natural enemies to suppress invasive weeds. Over the years 19 biocontrol agents have been released there to target species such as broomweed (*Sida* spp.), chromolaena (*Chromolaena odorata*), giant sensitive plant (*Mimosa diplotricha*), lantana (*Lantana camara*), mile-a-minute (*Mikania micrantha*), pig weed (*Mimosa pigra*), puncture vine (*Tribulus cistoides*), salvinia (*Salvinia molesta*), and water hyacinth (*Pontaderia crassipes*).

Over the past decade PNG's progress in weed biocontrol has stalled due to shifting national priorities and constrained funding. However, there is a desire to reignite this work with support from the BSI's Natural Enemies – Natural Solutions (NENS) programme, which is part of the Pacific Regional Invasive Species Management Support Service (PRISMSS). With climate change making invasive weeds worse, biocontrol is a key way to increase the resilience of Pacific communities and ecosystems.

In September the BSI undertook a scoping mission and facilitated a one-day National Stakeholder Workshop in Port Moresby in PNG, hosted by the Department of Agriculture and Livestock (DAL). The workshop brought together 30 participants from eight key organisations, including DAL, National Agriculture Research Institute, Conservation and Environment Protection Authority, University of PNG, Binatang Research Centre, youth awareness groups Eda Davara and Mastermind, and the Women and Youth in Agriculture network.

PRISMSS NENS technical lead for the Pacific, Lynley Hayes said, "the level of engagement and enthusiasm at the workshop was tremendous and we thank DAL for their support and extend our gratitude to all the organisations that participated in this event. We look forward to working with them in the future."

Participants at the recent workshop in PNG.

"This workshop was an important step in reconnecting partners, reviewing previous work and prioritising weeds for future biocontrol action," added NENS coordinator Annette Mwayawa of the BSI.

A weed prioritisation tool was used to identify the most important weeds for NENS in PNG. The top six weeds identified were: pig weed (*Mimosa pigra*), mile-a-minute (*Mikania micrantha*), African tulip tree (*Spathodea campanulata*), Koster's curse (*Miconia crenata*), spiked pepper (*Piper aduncum*), and molasses grass (*Melinus minutiflora*). These are a mix of novel targets and those for which natural enemies are readily available. Australia has a well-developed programme for pig weed, and the NENS programme is well placed to assist with African tulip tree agents.

The Solomon Islands also has a history of releasing weed biocontrol agents. Prior to the 2000s the Solomon Islands intentionally released seven biocontrol agents for weeds such as giant sensitive plant, Koster's curse, lantana, and water hyacinth. Since then, work on biocontrol has waned, but as in PNG there is renewed interest in restarting with the support of the NENS programme.

A prioritisation workshop was held last December in Honiara in the Solomon Islands to identify priority weeds for biocontrol. This event was hosted by the Environment and Conservation Department of the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM). Twenty key stakeholders from various environmental organisations attended, including the Secretariat of the Pacific Regional Environment Programme (SPREP), MECDM, the Ministry of Forest and Research, Biosecurity Solomon Islands, Barana Community Nature Heritage Park, Mai-Maasina Green Belt, Live & Learn Solomon Islands, Solomon Islands Rangers Association, Ecological Solutions Solomon Islands, and Solomon Islands Climate Action Network.

As in PNG, this workshop facilitated discussions on the potential use of natural enemies for weed management, the willingness of stakeholders to use this approach, and the feasibility of introducing natural enemies in the region. "There was again strong interest and commitment from the various organisations in implementing biocontrol strategies for managing invasive plants. Participants expressed enthusiasm for using biocontrol agents, and Biosecurity Solomon Islands reaffirmed their support, particularly for weeds impacting agricultural production due to high labour costs," said Chantal Probst, a researcher from the BSI, who helped run the workshop.

The weed prioritisation tool determined the top five priority weeds for NENS in the Solomon Islands to be: water hyacinth, African tulip tree, mile-a-minute, chromolaena, and Bengal clockvine (*Thunbergia grandiflora*). Three of these weeds, including African tulip tree, are low-hanging fruit since there are agents readily available. A weevil (*Neochetina eichhorniae*) has been released against water hyacinth in the Solomon Islands, but another weevil (*Neochetina bruchi*) is available in Australia and Vanuatu and prefers older leaves, so it could complement the attack of *N. eichhorniae*, which attacks younger leaves. Agents for chromolaena are also available in Australia.

Water hyacinth before biocontrol.

These workshops in PNG and the Solomon Islands, and the discussions held before and after, highlight a strong interest and commitment across a range of stakeholders for using natural enemies once again to control invasive plants in both these countries. The next step is to secure funding to allow work to begin against the priority weeds. By joining the PRISMSS NENS programme, these countries will join eight other Pacific countries already receiving support, such as technical expertise, capacity building, and scaling up proven biocontrol solutions to empower their communities to take local action against invasive weeds.

*The Restoring Island Resilience project, which supported this work, is funded by New Zealand's Ministry of Foreign Affairs and Trade and administered by the Secretariat of the Pacific Regional Environment Programme (SPREP). Under the umbrella of the Pacific Regional Invasive Species Management Support Service, which is hosted by SPREP, the Bioeconomy Science Institute leads the Natural Enemies – Natural Solutions programme, which provides support to Pacific Island countries and territories to restore ecological balance using safe, targeted biocontrol agents from the weeds' native ranges.*

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# Summer Activities

Summer is a busy time for many biocontrol agents, so you might need to schedule the following activities.

Broom gall mites *(Aceria genistae)*

- Check for galls, which look like deformed lumps and range in size from 5 to 30 mm across. Very heavy galling, leading to the death of bushes, has been observed at some sites.
- Harvesting of galls is best undertaken from late spring to early summer, when predatory mites are less abundant. Aim to shift at least 50 galls to each site and tie them on to plants so the tiny mites can move across.

Giant reed gall wasp *(Tetramesa romana)*

- Check release sites for swellings on the stems caused by the gall wasps. These look like small corn cobs on large, vigorous stems, or like broadened, deformed shoot tips when side shoots are attacked. The galls often have small, circular exit holes made by emerging wasps.
- It will probably be too soon to consider harvesting and redistribution if you do see evidence of the gall wasp establishing.

Green thistle beetles *(Cassida rubiginosa)*

- December is often when green thistle beetle activity is at its peak. Look for adult beetles, which are 6–7.5 mm long and green, so they are well camouflaged. Both the adults and the larvae make windows in the leaves. Larvae have a protective covering of old moulted skins and excrement. You may also see brownish clusters of eggs on the undersides of leaves.
- If you find good numbers, use a garden leaf vacuum machine to shift at least 100 adults to new sites. Be careful to separate the beetles from other material collected, which may include pasture pests. Please let us know if you discover an outbreak of these beetles.

Honshu white admiral *(Limenitis glorifica)*

- Look for the adult butterflies from late spring. Look also for pale yellow eggs laid singly on the upper and lower surfaces of the leaves, and for the caterpillars. When small, the caterpillars are brown and found at the tips of leaves, where they construct pontoon-like extensions to the mid-rib. As they grow, the caterpillars turn green, with spiky, brown, horn-like protrusions.
- Unless you find lots of caterpillars, don't consider harvesting and redistribution activities. You will need to aim to shift at least 1,000 caterpillars to start new sites. The butterflies are strong fliers and are likely to disperse quite rapidly without any assistance.

Moth plant beetle *(Freudeita cupripennis)*

- This beetle has established in the Bay of Plenty, Waikato, and Northland. Look for adult beetles on the foliage and stems of moth plant. The adults are about 10mm long with metallic orangey-red elytra (wings) and a black head, thorax and legs. The larvae feed on the roots of moth plant so you won't find them easily.
- It will probably be too soon to consider harvesting and redistribution if you do find the beetles.

Tradescantia yellow leaf spot *(Kordyana brasiliensis)*

- Look for the distinctive yellow spots on the upper surface of the leaves with corresponding white spots underneath, especially after wet, humid weather.
- The fungus is likely to disperse readily via spores on air currents. If human-assisted distribution is necessary, you will need permission from MPI to propagate and transport tradescantia plants. These plants can then be put out at sites where the fungus is present until they show signs of infection, and then planted out at new sites.

Tutsan beetle *(Chrysolina abchasica)*

- The best time to look for this agent is spring through to mid-summer. Look for leaves with notched edges or whole leaves that have been eaten away. The iridescent purple adults are around 10–15 mm in size, but they spend most of the day hiding away so the damage may be easier to spot. Look also for the creamy-coloured larvae, which are often on the undersides of the leaves. They turn bright green just before they pupate.
- It will be too soon to consider harvesting and redistribution if you do find the beetles.

Tutsan moth *(Lathronympha strigana)*

- Look for the small, orange adults flying about flowering tutsan plants. They have a similar look and corkscrew flight pattern to the gorse pod moth (*Cydia succedana*). Look also for fruits infested with the larvae.
- It will be too soon to consider harvesting and redistribution if you do find the moths.

National Assessment Protocol

For those taking part in the National Assessment Protocol, summer is the appropriate time to check for establishment and/or assess population damage levels for the species listed in the table below. You can find out more information about the protocol and instructions for each agent at: www.landcareresearch.co.nz/weed-biocontrol

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| Target | When | Agents |
|---|---|---|
| Broom | Dec–April | Gall mite *(Aceria genistae)* |
| Privet | Feb–April | Lace bug *(Leptoypha hospita)* |
| Tradescantia | Nov–April | Leaf beetle *(Neolema ogloblini)*<br>Stem beetle *(Lema basicostata)*<br>Tip beetle *(Neolema abbreviata)* |
| | Anytime | Yellow leaf spot fungus *(Kordyana brasiliensis)* |
| Woolly nightshade | Feb–April | Lace bug *(Gargaphia decoris)* |